OW TO AVOID INFECTION

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HARVARD HEALTH TALKS

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HARVARD HEALTH TALKS

PRESENTING the substance of some of the public lectures delivered at the Medical School of Harvard University, this series aims to provide in easily accessible form modern and authoritative information on medical subjects of general importance. The following committee, composed of members of the Faculty of Medicine, has editorial supervision of the volumes published:

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IT was a common saying of sanitarians of years ago that for every death from typhoid fever some one ought to be hung. The meaning was, that, as this disease is so often due to a polluted water supply, defective sewerage, or a foul privy, the city councilman, the health officer, or the landlord, responsible for the conditions, should swing on the gallows for his neglect. In those days it never occurred to any one that blame attached to the victim. While there is some truth in the old adage, as there often is in common sayings, it is more in accord with present day knowledge and modern conditions to say that if a man has typhoid fever it is his own just punishment for sanitary sins. We now know that each one of us can do a great deal to protect

himself from infection and that he has to depend less than formerly upon his fellow beings.

While this phase of the subject is here emphasized it must not for a moment be assumed that the share of the city, state and nation, in the preservation of the public health is less than formerly. On the contrary the need for these governmental activities is far greater and they are far more effective. It is still the duty of our officials to furnish a pure water, to construct sewers, to regulate housing conditions, to supervise the quality of milk and other foods, and to isolate contagious diseases in the home, or in the hospital. Indeed, the health work of the city is increasing and proceeding along new lines. It has to a large extent shifted from the environment to the individual, though the former is by no means to be neglected. Personal instruction, medical service and helps to right ways of living receive most attention. Hence we have the visiting

nurse, prenatal work, infant welfare stations, clinics for sick babies, tuberculosis dispensaries, the fight against nostrums, school inspection and the like. It is more important to remove adenoids from the child than it is to remove ashes from the back yard. It does more for health to fill decayed teeth than it does to fill sunken lots. It is more protection to the public health to detect the first signs of tuberculosis in the lungs of a young wage-earner than it is to detect a pin hole opening in a sink pipe.

To understand why health activities are now centering around the individual human being and how it is that the person can do relatively more than ever before to help himself to avoid contagion it is necessary to consider present day knowledge of modes of infection.

Fifty years ago almost nothing was positively known about the infectious diseases. Even thirty years ago the "germ theory" was little more than a

theory and unfortunately the guesses of this theory were often taught to the public as established truths. Although what we have still to learn is appalling, yet the advance, during the last generation, in accurate, firmly established, knowledge of infectious disease has been phenomenal. Applied in practice it has saved countless lives. Let us consider some of these facts.

In place of the haziest guesses about "germs" many different kinds of disease germs are known as definitely as we know the different kinds of trees and vegetables. It is possible to grow a crop of diphtheria germs, or cholera germs, or tuberculosis germs as certainly as it is to raise a crop of potatoes. It is known that these germs cause the diseases in question as surely as it is known that potatoes make good food, or that poison ivy causes skin disease. There are many different kinds of germs and they have

many different habits of life. Some we call bacteria. They are essentially of a vegetable nature akin to yeast and molds. The larger number of the more common disease germs belong to this group. Another group are more like the protozoa, or lowest forms of animal life. Among these are the germs of malaria and syphilis. Some germs of disease are extremely hardy, while many are frail and quickly perish. Some germs are so minute that they cannot be seen, even under the most powerful microscope, and almost nothing is known of their nature, yet they can be grown and made to cause disease. Their existence is determined just as surely as if they were as big as turnips. Though the virus of measles has never been seen, it has been carefully studied in the laboratory and enough has been learned about it to shorten, with safety, the period of isolation for this disease, from two weeks to one week. It must also be kept in

mind that, while there are some scores of disease germs known and classified, there are hundreds of kinds of germs which are entirely harmless and many which are of great benefit to mankind. When the germ of a disease has been discovered and can be studied it is easier to learn how the disease spreads, yet in some instances nothing is known about the germ, but there is very positive knowledge about how the disease is transmitted from person to person. Thus the germ of typhus fever is unknown, or at least its identity has not been fully established, yet even before its alleged discovery, it was proved that this disease is spread by lice and preventive measures based on this fact were found effective.

In the days of the old germ theory, when it was theory only, it was rashly assumed, because some germs grew abundantly in dead animal and vege-

table matter, that all would do the same. Hence arose the filth theory of disease, the spectre of which still haunts and hinders the health officer. This theory alleged that the germs of disease grew freely in the outer world, especially in all kinds of filth. It is now known positively that this is not so. Speaking broadly, the germs of disease do not grow outside of the living body. There are some important exceptions to this. Thus it is possible, under laboratory conditions, for the expert worker to cultivate most disease germs, but it is a difficult task and he often loses his cultures. It at times happens that one, or two, kinds of disease germs may grow in milk under natural conditions. It also is possible that the germs of one or two of the rarer diseases, like anthrax and tetanus may, under certain conditions, grow in water or in the soil.

Not only is it true that the germs of disease only very rarely grow outside of

the body, but they die, and often speedily. While disease germs do not grow in filth they may be transmitted in filth. The bacteria which cause typhoid fever, dysentery and cholera are discharged from the body in the excreta, and though they usually do not live very long, they live long enough to be carried from person to person, through the contamination of water, milk, and other things. This particular form of filth, namely, human excreta, though not the breeder of germs, frequently is the vehicle of germ transmission. This is about all the truth that there is in the old notion that all infectious diseases have their origin in filth.

If the germs of disease do not grow in the outer world it is properly asked what is their source? It can be said with certainty they never arise *de novo*. Typhoid germs are always bred from typhoid germs just as surely as roses

always grow from roses. As has been stated, disease germs grow almost exclusively in the body. In the case of human diseases their sole habitat is usually the human body, though unfortunately there are some exceptions, as tuberculosis which affects cattle and several other species of animals, and malaria the germs of which grow in the mosquito. In bubonic plague the bacillus has its home in the rat and only incidentally affects human beings.

Long before germs were discovered, it was known that smallpox, cholera, syphilis, plague and many other diseases are contagious, that is that sick persons can transmit the disease to the well. The search for disease germs was first made in the sick and there they were found. It was formerly assumed that it was only while sick that a person could spread disease and that the germs speedily disappeared as the patient became well.

One of the most important discoveries of bacteriology, and also one of the most disquieting, is that the germs of most diseases are not confined exclusively to the sick, but are frequently found in well persons. It was learned that the bacteria which cause diphtheria often remain in the throat for a time after the patient is well, sometimes for a few weeks, sometimes for a few months, more rarely for years. After typhoid fever the germs may still, for some weeks, be discharged in the excreta. In a few instances they become permanent inhabitants of the gall bladder and making their way thence into the intestines, may, intermittently, render the infected person a potential source of danger to others for years to come, sometimes for a lifetime. Such a person, well, but infected, is called a " carrier," a carrier of disease germs. Not only are there convalescent carriers, that is, those who have had the disease, but there are

also those who have come in contact with the sick, or with carriers, and have themselves become carriers without being sick at all.

The bacteriologist has taught us another disquieting fact, namely, that in most of the contagious diseases there are many mild cases, so mild and with so few symptoms that they are almost sure to escape detection. A child with a slight sore throat, and practically no other symptom, may be sent to school without being examined by a physician, yet many of these sore throats are really diphtheria, and the germs from them, may, in the next person, cause a fatal illness. A man may have a slight " bilious attack," or merely feel " under the weather," for a few days, yet really be a " walking case " of typhoid fever and, if he is engaged in the milk business, it often happens that he is the cause of an extensive outbreak of the disease. These

are what are called "missed cases" of disease. They miss recognition by the physician and health officer.

The number of carriers and missed cases varies greatly in different diseases. There are few in smallpox and measles. For every recognized case of diphtheria properly isolated in home, or hospital, there is probably a mild unrecognized case mingling freely with the public, and doubtless several well carriers. Almost three per cent of all typhoid fever cases become permanent carriers. For every case of cerebro-spinal meningitis there are probably ten, or twenty, practically well, carriers. Moreover, in some diseases, as in measles, the disease is intensely contagious for several days before the development of symptoms likely to be recognized. When a child is sick in bed with diphtheria, and every one knows it, the danger of the disease spreading is not one-tenth what it would

be if the same child had a mild sore throat, not recognized as diphtheria, and was going to school and mingling with the other children in play. Under modern conditions the known cases of contagious diseases are fairly well controlled. It is not from them that most disease comes, but from the carriers and missed cases. Neither you, nor I, nor the Board of Health, know where these are. The occupant of the next seat may, for all one knows, be a diphtheria carrier, so may the saleslady who ties up the package, the conductor who gives the transfer, or the expressman who leaves a parcel at the door. The dirty man hanging on the car strap may be a typhoid carrier, or it may be that the fashionably dressed woman who used it just before was infected with some loathsome disease. If these people were sick in bed we would avoid them. As it is we cannot. Science has shown this new danger. It cannot be escaped by old

methods. Later it will appear how much of it can be avoided.

To guard against disease it is necessary to know how the germs pass from one to another. In some diseases, of which malaria, yellow fever and typhus fever are examples, they are found in the blood. Such diseases are usually transmitted by insects. In other diseases the germs are found in the excreta from the intestines. Such are typhoid fever, dysentery, enteritis, and cholera. In smallpox and chicken pox the eruption on the skin is infectious. In by far the larger number of our common contagious diseases the infection is contained in the secretions of the nose and mouth. Even when the germs come from deep down in the lungs, as in tuberculosis and pneumonia, they are, by the act of coughing, discharged through the mouth. And in smallpox and chicken pox, the mouth, too, is infectious, even

before the eruption appears on the skin. To realize the importance of the saliva as a source of infection it is only necessary to name some of the diseases which coughing may spread. Among them are scarlet fever, diphtheria, septic sore throat, measles, whooping cough, mumps, chicken pox, smallpox, tuberculosis, pneumonia, influenza, syphilis, cerebro-spinal meningitis and infantile paralysis.

One of the most encouraging of the newer facts which have been learned about the contagious diseases is that the germs, after leaving the body, have a far shorter life than was formerly supposed. The old belief was that they became attached to the walls and furniture of the sick room, to clothing, books and toys and thereon retained their vitality for years, and that the articles thus became a most important source of danger. Hence arose the almost reli-

gious faith in the need for and efficacy of fumigation, which rite was believed to do away with all future danger.

There is a great difference in the vitality of germs. Some, as those of meningitis, pneumonia, influenza and gonorrhea, die very quickly. At times a half hour, or less, suffices. Direct sunlight kills most germs in a few minutes. Drying is rapidly fatal and, contrary to popular belief, warmth tends to destroy, while cold preserves them. Among the most resistent germs of the common diseases are those of diphtheria, tuberculosis and typhoid fever. If a considerable mass of typhoid excreta, or tuberculous sputum, or diphtheria membrane, be kept damp and cool and dark, some living germs may at times be found for many weeks. Such conditions are fortunately quite uncommon. In the average sick room it merely happens that a little tuberculous sputum, or a little saliva from a diphtheria patient,

is smeared on the bed clothes, the chair, the window sill, or on a book or toy. Here the material is thin, it is exposed to light and air and the germs speedily die. Careful search for diphtheria germs in rooms, even while the patient is still sick, rarely reveals them except on articles just infected. Although a few germs may live a considerable time, most of them die quickly. When a patient recovers from diphtheria the public are far more afraid of the room where he was sick than they are of the patient himself, or of his family. If they fear the patient at all it is his clothes not his throat. This attitude is well illustrated by the difficulty I had recently in persuading a woman, the wife of a physician too, that it was futile to disinfect the room in her house in which a child had just recovered from diphtheria. The fact was that while one child had been confined to bed by diphtheria a little brother, who was perfectly well, was a

carrier of virulent diphtheria germs and at the time disinfection was asked for, and for a fortnight previous, had the freedom of the house. Great fear was manifested of the dying and probably dead germs on the articles in the sick room, but no attention at all was paid to the human carrier who was an active, a very active, incubator of living germs.

For many years it was the fashion for so-called sanitarians to hold that the chief sources of infection were to be found in decaying organic matter and in the germs which cling long to articles which had been in contact with the sick. Among the most important results of modern scientific research is the discovery that disease germs do not grow outside of the body and that, discharged from the body, they usually die rapidly. It is the *fresh* secretions which are to be guarded against. Persons not things are to be feared.

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Now that it has been determined what is the source of infection, that it is human beings, and to a large extent human beings who do not appear to be sick, the next inquiry should be as to the way in which disease is transmitted from person to person. Here, again, our knowledge is far more definite than it was a few years ago.

Until very recently it was thought that the air was the chief vehicle of infection. This was but natural. No one could see infection and what was more natural than to think it gaseous like the invisible air. The breath of the patient was believed to contain it in its most virulent form, coming as it does, from the very vitals of the sick one. The germ theory, too, encouraged belief in air infection, for, when it was suggested that bacteria are the real cause of disease, it was assumed that such tiny particles could easily float in the air.

It was only as these germs came to be carefully studied, that the older ideas were shown to be erroneous. The first shock came when the bacteriologist showed that the expired air is entirely free from germs. The air we breathe generally contains a good many germs, harmless ones, more resistent than those of disease, but these are caught on the mucous membrane of the nose and throat and the expired air contains none of them. The reason that the breath is free from germs is that they are not thrown off from moist surfaces. Even a considerable current of air fails to dislodge them. The expired breath from a person with diphtheria, or scarlet fever, if the breathing is quiet, is entirely harmless. Because germs are not easily disengaged from moist surfaces, the air from privies, cesspools, and drains contains no germs from these sources. The sewer gas bogey is dead. One may breath the air from a soil pipe all day

and get fewer germs of fecal origin than he would in drinking his daily allowance of New York city water, and that is a safe water. Not only are germs not disengaged from the moist surface of sputum, saliva, feces and the like, but even when such substances become dry, the air around them does not become infected.

It was found, however, that when infected material is dried and pulverized, the resulting dust may be wafted by the air and thus carry living germs. This was demonstrated for tuberculosis and the germs of this disease have been found in the dust gathered near careless consumptives. It must not be inferred from this that other diseases are dust-borne, or that this is the usual method of infection in tuberculosis. As a matter of fact a great many kinds of disease germs have been sought for in dust from many places and they have rarely been found. Even in the case of tuberculosis

they are not found in the vicinity of careful patients. That street dust is the bearer of disease germs is highly improbable. The reason why dust is an unimportant factor in the transmission of disease is because drying kills germs. By the time infected material is dry and powdered under the feet the germs are usually dead. The reason why living tuberculosis germs are more often found in dust than any other is because they are a resistent variety and are contained in the sputum in enormous quantities.

While germs are not given off from moist surfaces, it is possible to disengage little droplets of the liquid which contains living germs. When a person coughs, or sneezes, such droplets are blown out of the mouth, or nose, and indeed may often be seen in the sunlight. Such particles may easily carry disease germs, but if they are large enough for this they speedily fall to the floor. If small enough to float any length of time

they are too small to be a danger as germ bearers. Droplets are not thrown off during ordinary breathing, or quiet conversation, but are by coughing, sneezing and loud talking. Droplet infection is a very real danger, but it is effective only at about an arm's length. Physicians and nurses occasionally contract disease in this way as their duties necessitate bending over a patient, often when the latter is sneezing, or coughing. A person sitting beside a diphtheria carrier in a street car, or at a lecture, is not likely to be infected as there is little chance of the carrier sneezing, or coughing in the face. If persons stand face to face and there is coughing, laughing, or loud talking, there is a decided danger. This is one of the many reasons for avoiding crowds. If possible, turn the face away, as then the chance of infection is very much less. We all have duties towards others as well as towards ourselves. In coughing we should turn

the face away from our neighbor, or shield the mouth with the handkerchief. This droplet infection is quite important, but it partakes more of the nature of contact than it does of aerial infection. A dangerous infection of the air of a room by droplets, dust, or in other ways is uncommon. Under conditions in this part of the world, in an ordinary clean sick room, or hospital ward, it is a negligible factor.

Infection by means of food and drink is important, but not so important as many suppose. Formerly polluted water caused a large amount of typhoid fever, diarrheal diseases, and cholera, but a rapid improvement has taken place and is still going on. Where a city still furnishes dangerous water, one is tempted to wish that the old adage about hanging someone might be made effective. Milk, too, is quite often the cause of serious outbreaks of typhoid fever, septic sore

throat and other diseases, as well as the source of considerable tuberculosis in children. Here, too, state and city ought to try earnestly to protect the public, though the problem is a difficult one. The public, however, has the matter in its own hands, for if only pasteurized milk is drunk the danger of infection is almost eliminated. Although few cities have an ideal milk supply, clean milk can be purchased in every city. The milk inspector will give every one the necessary information. The consumer usually has the choice whether he will drink clean and safe milk, or dirty and dangerous milk. The best way to improve the milk supply is for the consumer to purchase only the best milk. If pasteurized milk cannot be purchased milk can readily be pasteurized, or at least scalded, at the home. Occasionally outbreaks of typhoid fever are traced to oysters, celery, or other foods, but, except for what has already been mentioned, most infection

from food is due to the contamination of bread, cake, salad, fruit, etc., by means of the fingers. It is impossible to avoid all danger. We risk life and limb every time we ride in an automobile, or on the steam cars, or even when we cross a street. It is impracticable to avoid all food infection but it is possible to reduce it to a minimum by refusing food which is much handled and choosing such as has been recently cooked. Food cooked at home is safer than that purchased already cooked, for the latter has been handled by many more persons. Bread which has been wrapped is safer than that which has not. Milk which goes from producer to consumer in bottles is safer than "loose" milk. Apples which have been merely picked from the barrel by the grocer's clerk are less likely to carry infection than is the polished fruit which has been much handled by the peddler.

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The part played by insects varies greatly in different parts of the world. In the tropics it is of overwhelming importance. In the average northern city, insects, at present, are not a factor of very great moment. Doubtless flies do distribute some typhoid fever and dysentery. Although it would be delightful if our municipalities would successfully attack the fly nuisance, the individual can do much for himself. He can screen his house, and use fly paper, and decline to eat in fly-infested restaurants. If he happens to live in a malarious neighborhood, and the mesh of his window screen is fine enough, the malarial mosquito, also, will be kept out. Bubonic plague passes from rats to men by means of rat fleas which leave their dead hosts and attack human beings. Our seaboard cities may be invaded by plague at any time. The rat is the source of plague and the flea carries the plague from rat to man. It is easy to build the rat out

of our dwellings. When a man builds a house, or a stable, or a shed, he should build it rat proof. It costs only a few dollars more.

If a person happens to live in a malarious neighborhood it is well to locate the house as far as possible from the swamps, or marshes, where the malarial mosquitoes breed. It is not every kind of mosquito which carries malaria germs and it requires an expert to distinguish the dangerous kinds and find where they breed. The state, or local, health officer should be able to do this. Houses can be screened so as to keep out all mosquitoes, but *every* opening must be screened, even the chimneys. The screens must be fine, eighteen meshes to the inch, or the mosquitoes will get through, and screens must be kept in repair. In a malarious region it is a good rule to be out as little as possible after sundown, as it is then that malaria bearing mosquitoes are on the wing.

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By far the most important mode of infection is by contact. By contact infection is meant the quite direct transfer of the fresh material from person to person. This is the most obvious mode. It is what one would think of first. The reason why it has been so largely lost sight of is that so many persons contract disease who have never been in contact with the sick. So people invented the theory that disease germs are wafted by the air, or retain their vitality for long periods of time on articles which have been in the sick room, or grow in dirt and filth outside of the body. If it had been known how many unrecognized cases of disease there are, how many " walking cases " of typhoid fever, how many slight sore throats due to diphtheria, how many well " carriers " of cholera, or infantile paralysis, few would have questioned that the infectious diseases are spread chiefly by the contact of one human

being with another. Modern science has shown that the old theories just referred to are true, to a slight extent only, and that disease spreads through the community chiefly by the contact of person with person. This is particularly true of the common diseases of our own climate, the virus of which is so generally found in the saliva, or nasal secretions. In the tropics insect-borne diseases have a far more important place.

It is easy to understand, as will later be explained in some detail, how saliva may, in numberless ways, be transmitted from mouth to mouth. It is unpleasant to think of, and to many, at first, seems incredible, that the germs of such diseases as typhoid fever, which are discharged from the intestinal tract, should, in any direct manner, be transferred to the mouth of another. Observations have been made in a number of places, the Harvard Medical School among others,

which show that upon the hands of about ten per cent of medical students, nurses, and physicians, may be found germs which come only from the intestines. Among careless persons, with inadequate facilities for cleanliness, the percentage is doubtless very much greater. Such germs are readily recovered from the appurtenances and surroundings of the toilet and if, after the use of the latter, thorough washing of the hands is not the invariable practice, infected fingers may carry disease to their owner, or to others. That even educated people neglect such a reasonable precaution is shown by the experiments just referred to. If germs coming from such a source are readily found on and about people ordinarily accounted cleanly, how much more likely it is that saliva, and the numerous disease germs which it often contains, may be transmitted in similar ways.

Contact infection may be direct. Kissing is a recognized mode of direct con-

tact infection. The certainty of this mode is illustrated by a well authenticated incident recently recorded. At a small party of young people, where kissing games were not debarred, there happened to be a young man with a syphilitic sore on his lip. As a result of the party eight of the young people contracted syphilis. In a boarding school a girl, while beginning to develop the sore throat of scarlet fever, received her friends in her room. The only one who contracted the disease was the one who kissed her. There was no infection of the air of that room and the disease spread to no one, but by direct contact. Numerous other instances attest the importance of this mode of infection. Of course it is expected that lovers will continue to brave this course of danger, but is it not reasonable to ask others to reform. Gushing women, who kiss their neighbor's children, and schoolgirls who use this salutation as freely as a shake of

the hand, should learn that this meaningless use of the kiss disregards the canons of good taste, as it certainly does sanitary precepts. The venereal diseases are usually spread by immediate contact, though, as will be seen, by no means invariably so.

Indirect contact is far more important than direct. Perhaps the use of a common glass, for drinking, is the best example of a mode of indirect contact. It was also the first which the public learned to appreciate and avoid. The common drinking glass is going, but unfortunately has by no means gone. Even if the Board of Health neglects to enforce the law against it, no one need use it. That is within each one's absolute control. There are many persons who will not water a horse at a public fountain for fear of glanders who will themselves drink out of anything. The pencil is another effective vehicle for trans-

ferring one person's saliva to the mouth of another. The expressman puts it to his lips before making a note in his book and the maid at the door, or perhaps it is the "lady" of the house, a moment later, puts it to her lips before she signs the receipt. I have observed a nurse in a diphtheria ward lift to her lips a pencil which I had just seen in the mouth of a convalescent child. Little children put everything in the mouth and this is doubtless one of the reasons why children between the ages of two and six years are most susceptible to contagious diseases. Adults largely put away such childish ways but still numberless things go to the mouth which have no business there. Tickets, pins, needles, hat pins, money, any small object or bit of paper, is likely to be held between the lips. Any one of these objects may soon be used by another in the same way. The lips are used to point the thread for the needle, to wet postage stamps and enve-

lopes. The end of the string is held between the teeth by the market man while tying the bundle. An hour later the same string is used in the same way by the housewife in the home. Children "swap" apples, cakes, and lollipops. Not only do men exchange their pipes but every purchaser of a pipe in a shop is sure to try several to see how they draw. The pipe may thus be the means of distributing the germs of diphtheria, or syphilis. Usually the germs will become dry, and die before another tries the pipe, but sometimes a new purchaser comes within a few moments.

Probably the fingers are the chief means for the transfer of infection from one person to another. If one takes pains to watch his neighbors, or even himself if he is not well trained in present day rules of personal hygiene, it will be a surprise to note how many times the fingers go to the nose, or to the mouth, all unconsciously, for one pur-

pose or another, or for no purpose whatever. As I have elsewhere said: "Who can doubt that if the salivary glands secreted indigo the fingers would continually be stained a deep blue, and who can doubt that if the nasal and oral secretions contain the germs of disease these germs will be almost as constantly found upon the fingers? All successful commerce is reciprocal, and in this universal trade in human saliva the fingers not only bring foreign secretions to the mouth of their owner, but there exchanging them for his own, distribute the latter to everything that the hand touches. This happens not once, but scores and hundreds of times during the day's round of the individual. The cook spreads his saliva on the muffins and rolls, the waitress infects the glasses and spoons, the moistened fingers of the peddler arrange his fruit, the thumb of the milkman is in his measure, the reader moistens the pages of his book,

the conductor his transfer tickets, the 'lady' the fingers of her glove. Every one is busily engaged in this distribution of saliva, so that the end of each day finds this secretion freely distributed on the doors, window sills, furniture and playthings in the home, the straps of trolley cars, the rails and counter and desks of shops and public buildings, and indeed upon everything that the hands of man touch. What avails it if the germs do die quickly? A fresh supply is furnished each day."

It is easy to see how countless objects of the most common use are thus soiled with human saliva and with excretions of the body still more unpleasant. Many of these speedily reach the lips of another, for as the fingers are the chief agent in the distribution of infection, so also are they an important means of picking up infection. In examining the throat for diphtheria germs the physician uses a little swab of cotton with

which he removes some mucus from the throat which he then rubs upon the culture medium in the test tube which is placed in an incubator. If the germs are present they will grow finely by the following day. Our fingers are ten swabs which are continually picking up all sorts of dirt from door knobs, stair rails, car straps, counters, chairs, books, money, water closets, our own shoes and rubbers, and other things the list of which can be extended almost indefinitely. Visible dirt gathers quickly. With the visible dirt is also gathered all too frequently some of the secretions from another person. Often these secretions contain the germs of tuberculosis, or diphtheria, of meningitis, or scarlet fever. Watch again how often the fingers go to the lips. Unfortunately these finger swabs, unlike the cotton swab of the physician, plant their germs, not in the test tube, but on human mucous membrane. Often they do

no harm, for the germs may be too few in number, or of weakened virulence, or the body may be resistent. Many times they do grow and disease results. There can be little doubt that the fingers are one of the most important means of spreading the contagious diseases.

Infection frequently results from the contamination of food. Sometimes a large amount of food may be infected and a great outbreak of disease results. Such extensive outbreaks are usually due to milk, because the germs are easily scattered through the milk and perhaps sometimes increase in number. Far more often the infection is deposited on solids, bread, cake or fruit, perhaps only in one spot, in which case only one or two persons may contract the disease and its source will probably remain untraced. A ward maid worked for months in a scarlet fever ward in Provi-

dence without contracting the disease. Suddenly she developed scarlet fever and it was learned that two days before she had eaten some fruit secretly given to her by one of the patients. If the air of the ward had been infected, as is popularly believed, one would expect that she would have developed the disease earlier during her service. She did not, however, become sick until there was an opportunity for the quite direct transfer of secretions from the patient to her own mouth. One fact like this does not demonstrate a theory, but it is given as an illustration of many which show that contact infection is far more effective than air infection, even if the latter really exists, which for most diseases is improbable. A college girl just convalescent from typhoid fever had a small luncheon for her friends. They had no maid and handled the cake and other food freely. Four of the company developed typhoid fever and the hostess was

found to be a carrier of typhoid germs. There are numerous instances of waitresses who have infected others with typhoid germs deposited by the fingers on food, or spoons. The wrapping of baker's bread decreases the danger from repeated handling, but the baker may be seen to moisten his fingers on his lips in order the easier to pick up the paper. The fruit peddler, all too frequently, handles his fruit with unwashed hands and if an apple happens to roll in the gutter it is replaced on the stand without a thought. Waiters, in order to save trouble, will very often fill a used finger bowl from another table. If the bowls are metal this is more likely to be done as it is less easy to see whether they are clean. To wash the lips with such water and with one's fingers is not a cleansing process but the reverse. Wooden toothpicks on the table are not only handled by the waiters, but are likely to be by the guests.

On a car ride from New Haven to Providence two small children sat in adjacent seats, one in front of the other. They were strangers, but soon became acquainted. During the journey, a ticket, an apple, a cookie, a cup, a book, a pencil, and candy were observed to pass from mouth to mouth. If one child was a diphtheria carrier the other probably caught the disease.

Although syphilis is usually transmitted by immoral acts, nevertheless, owing to the fact that infectious sores are at times found in the mouth in this disease, its virus may be carried from person to person on all sorts of articles of common use. Dr. Buckley, of New York, devotes a whole volume to showing the numberless ways in which this disease may be thus innocently acquired. Among the vehicles of infection which he reports are " cups, glasses, spoons and other eating-utensils, pipes, toilet articles, underclothing, bathing suits,

handkerchiefs, bedding, pins, string, wind instruments of all kinds, glass blowers' tubes, pencils, coins, nursing bottles, sponges, syringes, surgeons' instruments, dentists' tools, and barbers' utensils." In most instances the circumstances were such as to indicate that the virus was in a quite fresh condition, that is these were instances of contact infection, not fomites infection.

This mode of infection by contact with the fresh secretions of persons who are met in daily life is very real and important. It is not only to be inferred from the established principles and facts of bacteriology, but it has also been demonstrated, time and again, as actually occurring. Curiously enough the best evidence concerns typhoid fever, a disease the virus of which one would think less likely to be spread in this way than are those diseases the virus of which is contained in the saliva. My attention was first called to the impor-

tance of contact infection in typhoid fever by Professor Sedgwick almost twenty-five years ago, in a report made to the State Board of Health of Massachusetts on an outbreak in a mill village. His graphic description of the open drains and overflowing vaults and filth in the yard, with the children playing about and then going into the house with their dirty fingers, to handle bread and cake, showed how short may be the route from case to case and how the disease may easily spread by contact from house to house and from family to family. Too little attention was paid to this mode of infection until the Spanish war, when investigation conclusively showed that the chief factor in the spread of the fever which devastated our camps was contact between the men in their tents and at the mess table. The troops in the Boer war had a similar experience. Knowledge of how to avoid this mode of infection, aided by the protective

power of typhoid vaccination, has rendered this disease of comparatively little importance in the far more terrible conflict which is now being waged in Europe.

Hookworm infection, which is such a serious matter for the South, is practically always spread by contact. In the rural South excreta disposal, before the recent sanitary awakening, was extremely primitive. The privy was largely unknown. General soil pollution with human excreta was common about dwellings. The eggs of the hookworm contained in the excreta hatch in the soil and bore their way through the skin of persons with whom they come in contact. The soil is, of course, also, often infected with the germs of typhoid fever and dysentery and in countless ways this infection is carried to the mouth, so that it is not surprising that these diseases have been extremely common.

The " sanitary privy " is urged in the South as the preventive for all this contact infection by human excreta and it is certainly a great improvement over no privy, but far from the ideal system by which all excreta are at once carried away from the premises by a sewer. In the North, we know by experience that many privies are far from sanitary. When they stand open, with overflowing contents, as in the instances described by Sedgwick, not only may flies carry the germs of typhoid fever to the house, but also the soiled hands and feet of people, and the feet of domestic animals, will often carry infection to household utensils as well as directly to food. The *unsanitary* privy is a great evil because it affords infinite opportunity for contact infection. As they are eliminated the number ot typhoid fever cases falls.

Dr. Levy, the well-known health officer of Richmond, Va., has shown that, sometimes, even the water closet does

not carry the sewer far enough into the home to eliminate all danger from excreta. He found that the neglect of diapers, their exposure about the room and careless handling, are frequently the means of the spread of the intestinal diseases of infants from child to child.

The importance of contact infection in typhoid fever, dysentery, and diarrhea is here emphasized to show how much safety depends on individual effort. In cities the government can do much by providing adequate sewers and compelling the removal of privies, but in the country sewers are impossible and in rapidly growing towns sewers rarely keep pace with the increase of population. A privy, open, neglected, and dirty, is a menace to owner and neighbors. It is the business of the owner to see that it is clean and flyless. The city may build sewers and compel the installation of closets, but it is the duty of the occupant to keep them clean and see

that all excreta are promptly deposited in them.

One of the most suggestive instances of infection through the carriage of disease by persons was the experience of one of the best hospitals for babies a few years since, when the importance of this mode of infection was not so well appreciated as at present. The management was greatly annoyed because, on several occasions, gonorrheal infection was introduced and spread quite extensively among the children. Every effort was made to prevent this. The cases were isolated and separate thermometers, utensils, napkins, etc., were used. Separate nurses were employed to a considerable extent. The occurrence of cases in distant wards was considered inexplicable until it was found that a nurse who had cared for the infected cases had also attended these babies. It was also found that while the greatest care had been bestowed on utensils and

clothing, sufficient attention had not been given to the nurse's hands. When the rule was enforced that the nurses thoroughly wash and disinfect the hands after bathing and dressing each child the spread of the disease was checked.

Much light is thrown upon the mode of infection of the contagious diseases by the experience of hospitals where they are cared for. Formerly it was believed that these diseases were spread almost exclusively through the air. Separate buildings were required for the different diseases. To care for cases in adjoining rooms, with the doors open, was considered criminal folly. So great was the fear of air carriage that a contagious disease hospital was considered a great menace to a neighborhood and the citizens rose up in mass to protest if it was proposed to erect one in their vicinity. The English government forbade the erection of a smallpox hospital within a

mile of a thickly settled locality. Now we know that disease is not air-borne from such hospitals. If smallpox goes across the street it is not because it blows across, but because some one carries it across. Careful observations in Boston and Providence show that there is no spread of any of the contagious diseases to the houses immediately adjoining the hospital. Even the prejudiced learn by experience. In Providence the property owners rose in wrath against their representatives for failure to stop the building of the hospital for contagious diseases, but soon after it was completed it was admitted that, owing to the attractive grounds, the price of adjoining real estate had greatly increased. In Detroit fine houses have been built right up to the hospital and this, too, with a full knowledge that smallpox cases are there treated.

While disease is certainly not carried by the air from hospitals to surrounding

dwellings it has been frequently transmitted, in some way, from patient to patient within the hospital. Patients admitted for diphtheria have contracted scarlet fever and those admitted for measles have contracted chicken pox. It was formerly thought that these "cross infections" were the result of air transmission, though it was difficult to account for them when the cases were in distant wards.

The rapid increase of knowledge concerning modes of infection made it apparent to hospital superintendents that the air has little to do with cross infections. Disease spreads because one article, or another, infected with fresh secretions, has passed from patient to patient, or because physician, or nurse, has failed to clean the hands properly. The surgeons and their nurses had learned how to avoid infecting their patients by aseptic methods and soon it was seen that the same aseptic nursing

would prevent the spread of scarlet fever, diphtheria, smallpox, and other contagious diseases. As strict cleanliness, or asepsis, began to be employed in wards for contagious cases, cross infections became rare, and it is entirely possible to care for several contagious diseases in the same ward with very slight danger of disease extending from patient to patient. For many reasons it is not usually desirable to do this, but it is a common practice to care for them in separate rooms opening on a single corridor and attended by the same physicians and the same nurses. That disease rarely spreads shows that contact is the chief mode of infection and that it is entirely possible to avoid it by scrupulous care in every detail of cleanliness.

The chief lesson to be learned from what has gone before is that contact with the fresh secretions, or excretions,

of human beings, is the most important source of infection for most of our common contagious diseases. By turning the face from the coughing and loud talking of our neighbors; by putting nothing in the mouth except clean food and drink; by never putting the fingers in the mouth, or nose; most contagious diseases can be avoided. Wash the hands well before eating and always after the use of the toilet. Teach this to the children by precept and especially by example. Modern sanitary science enables the individual to protect himself even if his health department is inefficient. The health officer may not enforce the law against the common drinking glass but no law compels you, or me, to drink out of it.

Many of the means of preventing disease, or regaining health, are costly. The introduction, or even the purification, of a municipal water supply may require millions. Sewers and plumbing

are expensive. An isolation hospital and its maintenance are a continuous and considerable drain upon the public purse. Efficient milk inspection cannot be had for nothing and good milk costs more than poor milk. Our health departments are constantly asking for more money for school inspection, for food control, for anti-tuberculosis work, for saving the lives of babies and for many other things and the guardians of the municipal treasury often have to refuse these demands.

It is often said that it costs nothing to be clean. This is not strictly true but it costs very little. The kinds of cleanliness most important for health are practically no expense. To wash the hands before eating and after the toilet cost nothing. It is no drain upon the purse to keep the fingers out of the mouth. If these simple precautions enable a ward maid to work all day among

diphtheria patients, without contracting the disease, they ought to protect the average man or woman in the daily round of life. Personal cleanliness is the cheapest insurance against infection.

There are not a few who scoff at the progress of science. They say that science merely presents a succession of theories, the new displacing the old. Medical and sanitary science, in particular, receive their sneers. What is true in medicine today, they say, will be held false tomorrow. Common sense, they think, is the only safe guide. Such people believe that the "germ theory," as they call it, and all that depends upon it, will speedily go the way of all previous medical delusions. Well, suppose we admit that much of the present day teaching about contagious diseases is a mistake. I do not, of course, for an instant doubt that the conclusions of sanitary science are, in the main, truths

which, however much they may be amplified and extended, will not be controverted. If one should admit, however, that much of what is here said is error, it is error which can do no harm. Some mistakes are expensive, but to acquire the habit of washing the hands and keeping fingers and miscellaneous objects out of the mouth can do no harm. To acquire habits of cleanliness is the line of decency along which the human race is progressing. Our forbears of the Elizabethan age threw their filth in the street and their garbage under the table. We have better manners. Though we may refuse to learn, certainly our children will learn, the habits of personal neatness here considered and will look at many common practices of today as we do at the uncleanly habits of our not distant ancestors.

Thus far only the means of preventing the transfer of contagious disease germs

has been discussed. Every one is asking whether it is not possible to so fortify the body that it can withstand the assaults of these germs. Every one now-a-days knows about carriers. Disease germs frequently get into the body and are found growing in the mouth, the nose, the intestines, and in other parts without being able to break down the defense of the tissues and make the carrier sick. Why this is so is a problem which scientific men have long been trying to solve, but with not very much success. Many things have been learned, but many more remain to be learned.

It is a popular belief that a strong vigorous body can withstand infection much better than a puny one and that it is the weaklings who are most likely to contract scarlet fever, diphtheria, or infantile paralysis. Such however does not appear usually to be the case. There seems to be no evidence that the common contagious diseases are not just

as likely to attack the strong as the weak.

There is, however, at least one most important exception. In tuberculosis, habits of life which tend to give strength and vigor to the body, not only render the body less liable to infection, but may even cure the disease after it is established. Plenty of fresh air, good food, proper exercise and moderation in all things are certainly a great protection against this infection. Conversely, overwork, the abuse of alcohol, other excesses, deficient or improper food, and lack of fresh air break down the resistance of the body cells so that tubercle bacilli can gain an entrance and begin their destructive and deadly work. While it is probably true that there is a certain hereditary predisposition to this disease, even this can largely be overcome by right modes of living. It remains true that it is largely in man's own control whether he have tuberculosis. Often a

bad inheritance combined with poverty, or other unfortunate surroundings, render escape impossible, but more often rational and healthful modes of life are sufficient to protect. Each one should try to shun infection by avoiding contact with the secretions of others and at the same time strengthen the body to withstand infection by living a healthful natural life.

Pneumonia causes almost as many deaths as does tuberculosis, though, as it is an acute, rather than a chronic, disease, the amount of disability and the loss of earning capacity are not as great. There is some disagreement as to the importance of the different factors involved in the causation of this disease but most are of the opinion that susceptibility is essential. The germs are found in large numbers of well persons who only succumb when their bodily strength is weakened by other illness, by senile decay, by malnutrition at the

other extreme of life, by exposure, and by the use of alcohol. Almost all the infectious diseases predispose to pneumonia and pneumonia is very apt to be the ending in any wasting, or debilitating, disease. As good food, fresh air, exercise, and hygienic living generally, are a safeguard against tuberculosis, so, also, are they against pneumonia. Habitual sleeping in an abundance of fresh air and training the skin, by cold baths and friction, to respond quickly to changes of temperature, protect against both diseases.

The effect of the use of alcohol in predisposing to tuberculosis and pneumonia has just been referred to. Although there is no evidence that the abuse of alcohol renders a person more likely to contract smallpox, typhoid fever, diphtheria, or infectious diseases, other than the two which have just been mentioned, it is the experience of all practicing physicians that excessive and often the mod-

erate use of alcohol affects the tissues of the body so unfavorably that such users of alcohol are much less likely to recover than are non-users.

There is an entirely different kind of immunity against infectious disease which has been observed for centuries, the immunity which one attack of a disease develops against a subsequent attack of the same disease. There is a *tendency* towards the development of immunity in nearly, if not quite all, infections, but in some, immunity is only partially developed or speedily disappears. In others it is strongly developed and lasts for a long time, often for life. Smallpox, measles and typhoid are examples of diseases with lasting immunity, but diphtheria is a disease in which immunity does not often last very long. It must be remembered, too, that the duration of immunity varies in different persons and under

different conditions. Thus in smallpox the immunity resulting from one attack of the disease, particularly if it occurs after adolescence, almost always lasts during the remainder of life. If the first attack occurs in infancy it is not quite as likely to last through life, though in the majority of instances it does. A very very small percentage of persons who have had smallpox have a second attack when exposed to the disease. Nevertheless protection is so nearly complete that persons who have had the disease have no fear of caring for others who are sick with it. So, too, mothers whose children have passed through measles and whooping cough have no fear of their playing with children who have these diseases. There are individual exceptions, however, to the rule of immunity and children, sometimes, though rarely, have these diseases a second time. Attention is here particularly called to these rare and indi-

vidual exceptions to the laws of immunity because failure to keep them in mind has given rise to much bitter discussion and much misunderstanding. Even in those diseases in which acquired immunity is the most complete and permanent, second attacks do occur in certain persons.

The enormous value of this acquired immunity against infectious disease has led physicians for ages to cast about for some means of producing it artificially without subjecting one to the danger of passing through a naturally acquired attack. The Chinese, centuries ago, seem to have discovered that if a person is inoculated with smallpox with a lancet, instead of acquiring it in the natural way, the attack is much less severe and is usually recovered from, though the immunity is as complete as that following the natural disease. This practice of inoculation was introduced into Europe and America in the eighteenth century

and became very popular, though it was well understood that the inoculated disease sometimes ended fatally.

Late in the same century, Jenner discovered that cowpox, a mild disease of cows and resembling smallpox, could be transferred to human beings and would protect them against smallpox as well as would an attack of the latter disease itself. This was called vaccination and at once displaced the older method of inoculation. It is now generally believed that cowpox is really smallpox permanently modified by passing through the cow. The immunity by vaccination, though as complete as that produced by the disease itself, is probably not so permanent and if children are vaccinated in infancy it usually, though not always, "runs out," as it is said, before they reach adult life. A second vaccination, after adolescence, usually protects for life. One of the best demonstrations of the efficiency of vaccination is afforded

by the experiments made at about the time of Jenner's discovery. Jenner himself after successfully vaccinating a number of persons inoculated them with material from a smallpox patient without causing smallpox. Dr. Waterhouse, of Boston, who introduced vaccination into this country, vaccinated his own children and tested them in the same way. In the neighboring town of Milton in 1809 twelve children who had been vaccinated in July were, in the autumn, inoculated with crusts from a case of smallpox but none of them showed any signs of the latter disease. Another striking demonstration is afforded by the fact that vaccinated physicians and nurses have, for over a century, been in the closest contact with smallpox, almost invariably with perfect protection. For a person properly vaccinated to contract smallpox is a very very rare thing. Such exceptions occur in all forms of immunity, natural and acquired.

The symptoms produced by vaccination are usually transitory and mild. With modern methods untoward results of any kind occur only with the greatest rarity. In the Health Department in Providence are the names of nearly 140,000 persons who have been vaccinated by the department physician. No one has ever died. There has never been any permanent disability. On the other hand last year automobiles killed thirty-seven persons in Providence and maimed many more, yet there are few who decline a motor ride for pleasure, because of the not inconsiderable danger. Every one owes it to himself and to the state to see that he and his family are adequately protected by vaccination against smallpox.

The immense value of vaccination against smallpox led physicians to make diligent search for means for producing artificial immunity against other infections, but without success until the

relation to disease of bacteria and other micro-organisms was discovered. Pasteur, the founder of the modern science of bacteriology, pursued his studies, stimulated largely by the hope of finding some means of vaccinating against other diseases besides smallpox. He tried to so modify the virulence of disease germs that they could gradually be introduced into the body without making a person seriously sick, but with the power to stimulate the tissues so that they would develop a resistance to a subsequent attack.

It was by an accidental discovery of a means of weakening the power of bacteria that he obtained his first success with fowl cholera, a common disease of poultry. He found that he could, with these weakened germs, safely immunize poultry against subsequent attacks. Similar methods were employed by Pasteur against several other animal diseases and his methods have been

made use of practically by the stock growers of Europe. In our own country, too, tens of thousands of farmers are employing a protective vaccination of swine against hog cholera. Commercial interests, measuring the value of immunization in dollars and cents, make use of it. While many a man is quick to protect his pigs against cholera, he fails to make use of means to protect himself against smallpox. The chief value of Pasteur's discovery was, however, the impetus it gave to similar investigations on immunity in human diseases. The problems involved in the laboratory study of immunity are exceedingly complicated and have attracted the brightest minds in many lands. Though an immense field still remains to be explored, much of practical value has already been learned. Pasteur himself worked out a process of immunization against hydrophobia which is now employed throughout the

world. With a weakened virus it is possible, even after a person has been bitten by a rabid animal, to produce an immunity before the disease has time to develop. When a dog, or any other animal, bites, his brain should at once be examined at some laboratory, if there is any possibility that the animal was rabid. If infection is shown, the preventive injection of the bitten person with weakened virus should be begun at once. Protection is almost certain.

It has also been found that in certain diseases dead bacteria, or even substances extracted from them, are capable of producing immunity. This is notably true for typhoid fever. Cultures of the typhoid germ are prepared and then killed and measured doses injected under the skin. Two, or more often three, doses are given at intervals of about a week. Sometimes the person so treated feels quite sick for several

days, but usually the symptoms are not at all severe and last only for one to three days. It is not known how permanent this immunity is, but it is probable that it usually lasts for at least a year and often for two, three, or four years, or even longer. Its value was perhaps best shown when our troops were mobilized in Texas in 1911. In the Spanish war, in a camp of over 10,000 men not vaccinated against this disease, twenty-five per cent had typhoid fever and nearly ten per cent died. This had very commonly been the experience of armies in other wars. In 1911 in a camp of 12,000, mostly protected by vaccination, at San Antonio, there were only two cases of typhoid fever and both recovered. Although camp sanitation had improved greatly it could not explain the immunity, for the men were on frequent leave in the city where typhoid fever was continuously present. In the present European war the beneficial re-

sults of typhoid immunization have been appreciated by all the governments.

Nurses in contact with typhoid fever frequently contract the disease. It is now a very common practice for them and for physicians to protect themselves by this method of immunization. The fact that the immunity is not nearly of so permanent character as that produced by vaccination against smallpox and is not so easy of application, prevents that universal employment which is so desirable for smallpox vaccination, yet such immunization is of very great practical value. It should not only be employed in armies and by physicians and nurses, but also by every one who is especially exposed to the disease. Members of the family where there is a case of typhoid fever would usually do well to be immunized. So too, during an outbreak due to water, or milk, those who have used the infected water, or milk, should

be immunized. Persons living in a town where the water is known to be dangerously polluted, or in any community, where this disease is rife, should protect themselves in this way. In certain rural portions of the South, many thousands of persons have taken advantage of this protection. If one lives in a city like Boston, where typhoid fever has been reduced to a very small number of cases, immunization should be employed if travel is contemplated to any place which is not known to be comparatively free from the disease.

Protective vaccination of a similar kind has been used with some success against cholera and bubonic plague. At present, fortunately, this is not of much practical importance to us here in New England.

There is still another way of producing immunity, but it is not usually so lasting. It is possible, by injecting into

animals — usually horses — increasing doses of the toxins, or poisons, which different disease germs produce, to develop in the blood antidotes, or antitoxins as they are called, though the animals are never infected with the germs. The antitoxin from the blood of the animal when injected into a human being, suffering from the same disease, neutralizes the disease poison and so assists recovery. When antitoxin, in proper dose, is injected into a well person, that person is immunized, or protected, against the disease, but usually only for a short time. Thus a person can be protected against diphtheria in this way usually for only about three, or four, weeks. This, however, sometimes proves very useful, for when one has been exposed directly to diphtheria in the family, or in an institution, or when virulent germs are found in the throat, this temporary immunity is sufficient to tide over the danger. Nurses in diph-

theria wards are frequently immunized in this manner. Many persons are for some reason naturally immune to diphtheria and it is easy to determine this by a very simple and painless skin test which if negative shows there is no need of further immunizing such individuals. If, however, susceptible persons have been thoroughly exposed to diphtheria, particularly if they cannot be kept under very close medical supervision, preventive treatment with antitoxin is often desirable.

It is not in every disease that effective antitoxins can be produced and even in some, where they are of value for the cure of disease, for one reason or another, they are not of much use for prevention. There is one most serious disease in which antitoxin is of the greatest preventive value and that is tetanus, or, as it is commonly called, lockjaw. This disease is caused by germs which are found in the manure

of animals. Unlike nearly all other germs which affect human beings, they are possessed of great vitality and may live for years, so that they are commonly found, not only about stables, but also in the dirt of streets and in cultivated soil and indeed anywhere that the dust from such places is carried. Infection usually takes place only by way of rough, lacerated, or punctured wounds, through which the germs are pressed into the tissues where they can grow. Such wounds should never be neglected, but a surgeon should be seen as soon as possible, who will thoroughly clean them out. In addition it is also often desirable to inject tetanus antitoxin, which is a most valuable preventive. In 1903, tetanus following Fourth of July accidents caused 417 deaths while in 1915 there was only one. Although the larger part of the improvement has been due to a "Sane Fourth," much of it is due to a more prompt and better treatment

of wounds and not a little to the use of antitoxin.

Malaria is one of the most serious of all human diseases, but, fortunately, in the northern United States it is not now very common. Its mode of transmission by certain species of mosquitoes has already been referred to as has the means of guarding against these insects by draining, oiling, and screening. These measures usually require community effort, which may be lacking. Again, travel often takes one into regions which are intensely malarial and where the attacks of mosquitoes cannot be guarded against. The individual here would be helpless if it were not for one very simple measure of protection. By taking a few grains of quinine daily, while in the malarial region, the disease may be almost surely averted. Although many parts of the Panama Canal Zone were entirely freed from mosquitoes, at times there were places where they could

not be entirely eliminated and, of course, during the inception of the work they were a constant menace. When so exposed, large numbers of the American force, including General Gorgas, took these preventive doses of quinine with markedly beneficial results. No one should travel in a malarial region without a plentiful supply of this drug.

It is the gibe of the thoughtless that the sea and the sky and the earth are now so peopled by science with a frightful multitude of germs that continual fear of them makes life no longer worth the living. Although science has discovered some unpleasant facts, the pseudo-science of the careless magazine writers and the sensational reporters for the yellow press, are chiefly responsible for the unreasonable fear of disease germs which is too often found among intelligent people, as well as for unwise and ineffective methods of protection too often

relied upon. It is the business of science to discover truth and teach the truth. To teach the truth is right. To teach even the slightest deviation from it is wrong. It is not true that sanitary science has, through fear, made life a burden. It is quite the reverse. A known danger may cause fear, an unknown danger causes terror. When the mode of spread of yellow fever was unknown a single case threw all our southern states into a frenzy. Science may have taught our southern neighbors to fear the yellow fever mosquito, but if this disease now appears they go about their business as usual, knowing that science has taught the officials effective methods of control. In 1892 all our seaboard cities were in a panic over the advent of cholera. Ships from cholera infected ports were absolutely refused a landing. Since then, we have learned the before unsuspected danger of the well known carrier of the disease, but

this knowledge, coupled with knowledge of the modes of infection and means of control, so allayed popular fear that in 1911 ships from cholera ports landed their passengers in Boston and Providence and New York with only the passing interest of the public.

Science has not peopled the air with the germs of disease, but, on the contrary, has shown that such are rarely if ever air-borne. We may now live with equanimity opposite a hospital for contagious diseases. We no longer hurry, with closed nostrils, past a house with a scarlet fever placard. We are no longer in terror of some all pervading epidemic influence from which there is no escape. We do not worry about the "fall fever" which came regularly and mysteriously, for we now know just how typhoid fever is spread and how it can be avoided. This knowledge has eliminated nine-tenths of the disease in Boston and typhoid fever is no longer a

terror. Science has substituted the walking human carrier for the flying germs of the air, and what is more, has taught us that if we wash our hands and keep everything out of the mouth except clean food and drink a carrier will rarely do us harm. Science allays fear by substituting light for darkness.

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